Spinal Surveillance for Scoliosis in Children with Cerebral Palsy

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Scoliosis in Cerebral Palsy

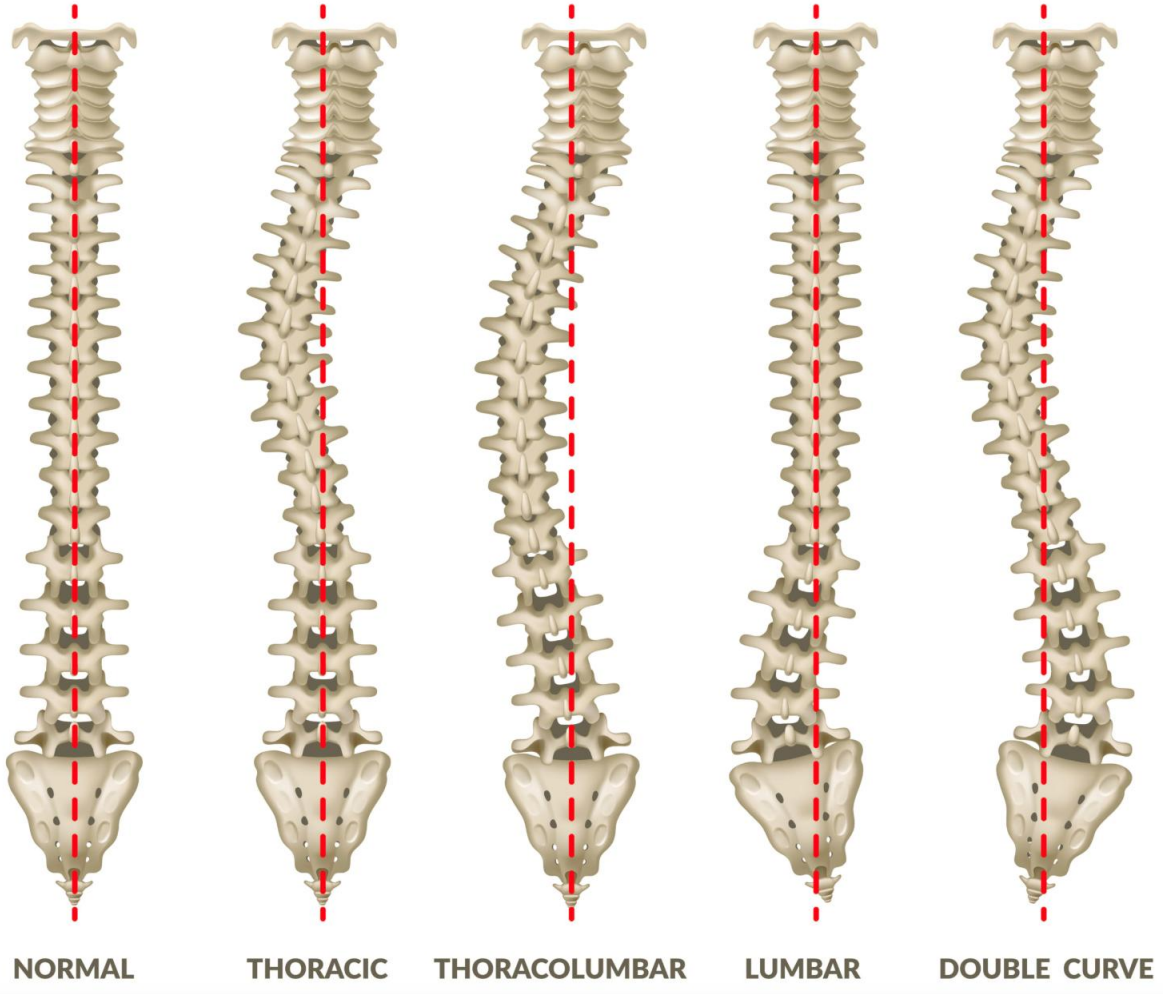
Neuromuscular scoliosis

41% incidence of scoliosis in young people with CP in Australia (mean age 21 years)

(Willoughby et. al, 2022)

Severe scoliosis complications (Koop 2009):

- Pain
- Pelvic obliquity
- Seating instability:
  - Vision, Communication, Feeding
  - Reach and bimanual activities
- Restrictive lung disease
- Skin pressure areas
- Reflux



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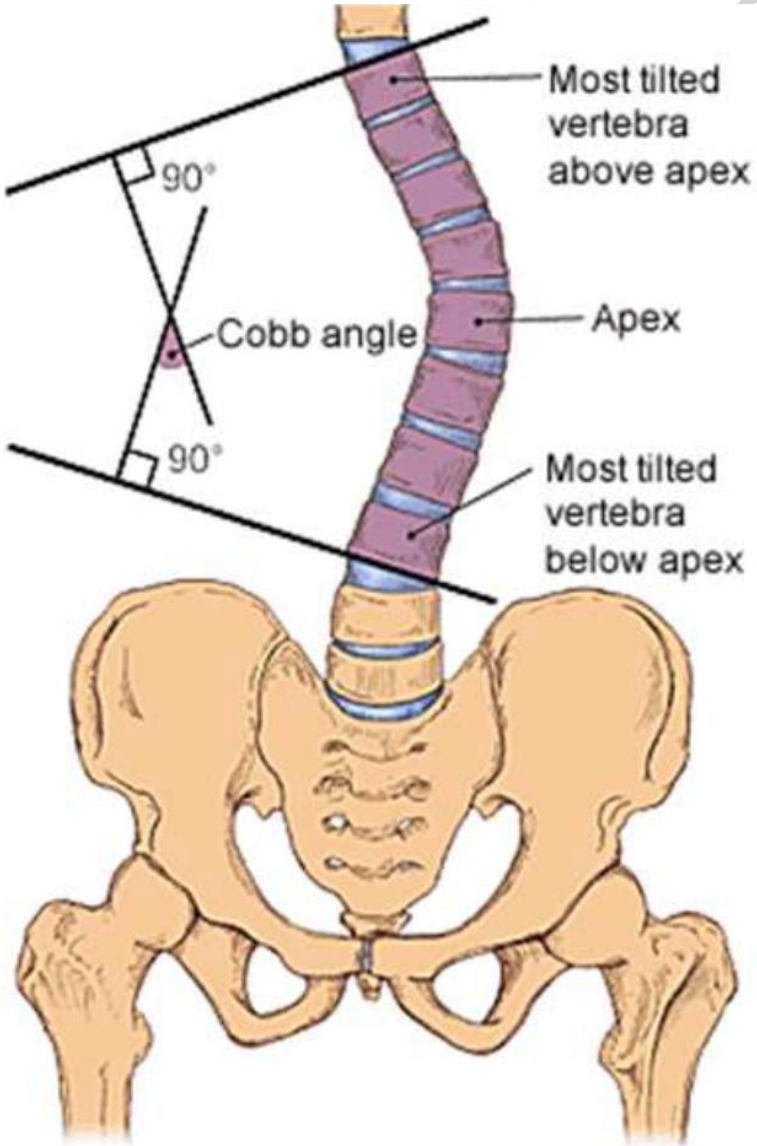
Scoliosis in Cerebral Palsy

X-ray is gold-standard for measuring Cobb angle

Scoliosis Severity

Angle in degrees	Category
0 to 10	Normal spine
Between 10 to 20	Mild scoliosis
Between 20 to 40	Moderate scoliosis
Greater than 40	Severe scoliosis



(Reference: Maaliw III et.al, 2022)

Measuring Cobb angle on spinal X-rays, $\Delta > 10^{O}$ is 95% likely to represent a true change in spinal curvature (Carmen D et.al, 1990)

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Scoliosis in Cerebral Palsy

Risk factors scoliosis progression:

(Persson-Bunke et.al 2012; Bertoncelli et.al 2017; Hagglund et.al 2018)

- ↑ Age
- Higher GMFCS level
- Female
- Hip subluxation/dislocation, Previous hip surgery

Saito et.al (1998):

- n=37
- Participants: 40.5% quadriplegic severe CP, 59.5% mild-moderate quadriplegic, diplegic and hemiplegic CP
- 85% Cobb > 40° by 15 years, progressed to Cobb ≥ 60°

Gu et.al (2011):

- n=110
- Participants: spastic quadriplegic CP GMFCS V 99%, GMFCS IV 1%
- Cobb > 40° by 12 years scoliosis more likely to progress.

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Scoliosis in Cerebral Palsy – current practice

- No evidence-based guideline for radiological surveillance of scoliosis in children with CP
- Australian Hip Surveillance Guidelines for children with Cerebral Palsy (2020)

- General guideline childhood scoliosis surveillance:

International Society on Scoliosis Orthopaedic and Rehabilitation Treatment

2012 Consensus Statements on frequency of spinal X-rays:

- 0 to 5 years old, early onset scoliosis every 6 months
- 6 to 12 years old juvenile scoliosis every 6 months
- 13 to 18 years old with adolescent idiopathic scoliosis every 12-18 months

Research Aims

Why?

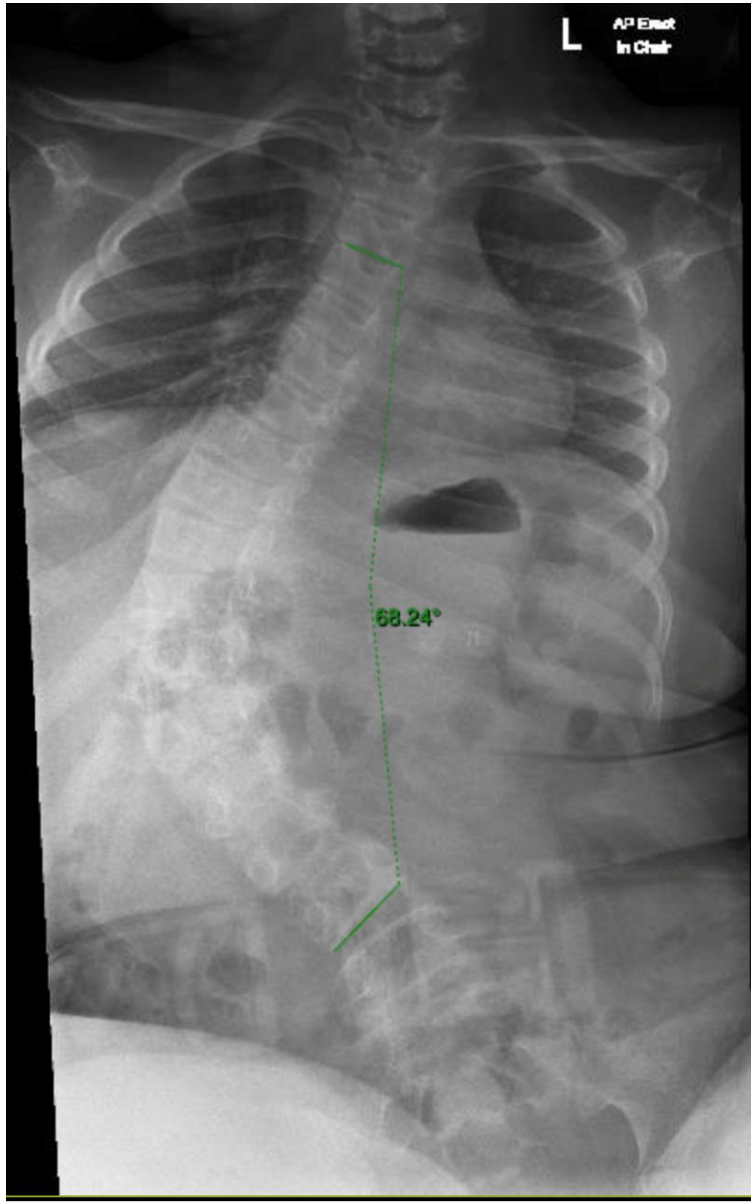
- Measure scoliosis progression on X-rays over time, children with CP who are more at risk of progressive scoliosis, to inform development of a clinical guideline for spinal surveillance.

How:

- Observing if a Δ Cobb angle $\geq 10°$ from the baseline spinal X-ray, can be detected at 6 month, 12 month, or 18 month intervals.

Study Design

- Prospective longitudinal observational study
- HNEkidsRehab Database
- HNE LHDs
- Spinal X-rays at 0, 6, 12 and 18 months
- 3 investigators measuring Cobb angles on PACS
  - Consensus on measurements
- Data stored on REDCap
- Quantitative data analysis



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Study Design

Participants

Inclusion criteria:

- CP GMFCS III, IV or V
- Age 8 – 17 years old

Exclusion criteria:

- Previous spinal surgery or had spinal surgery during the study
- Pregnancy

Ethics

- HNE HREC – greater than low risk pathway
- HNE Area Radiation Safety Committee
- Radiation Dosimetry Report
  - ➢quantifying radiation exposure
- HNE Imaging
- Site Specific Assessment

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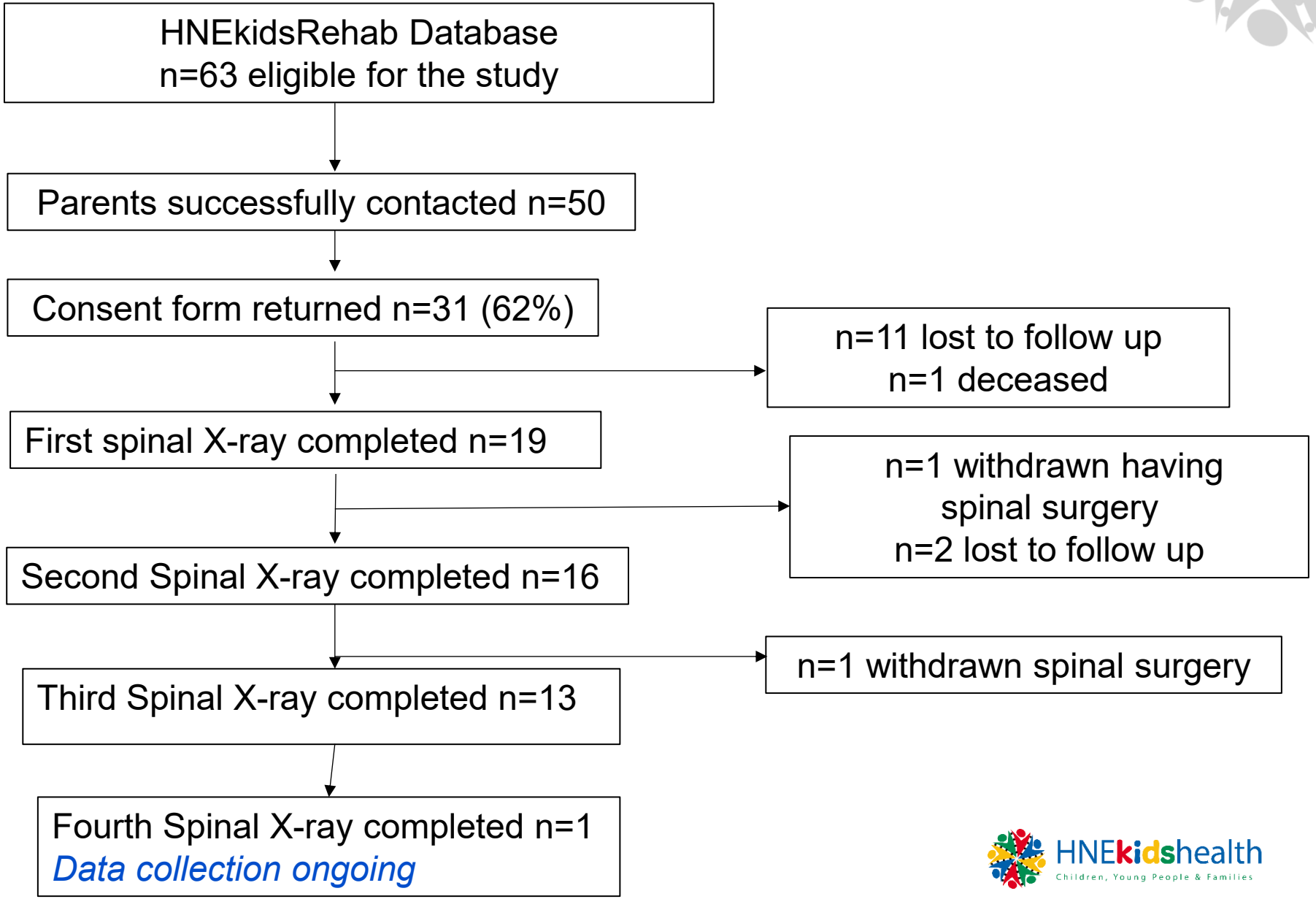
Participants



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Results

Descriptive Statistics	
Sex	
Male	10/16 (62.5%)
Female	6/16 (37.5%)
Age (years)	
Mean	10.9
GMFCS	
III	1/16 (6.2%)
IV	9/16 (56.2%)
V	6/16 (37.5%)
CP type	
spastic	1/16 (6.2%)
dystonic	2/16 (12.5%)
dyskinetic	1/16 (6.2%)
hypotonic	3/16 (18.7%)
mixed tone	9/16 (56.3%)

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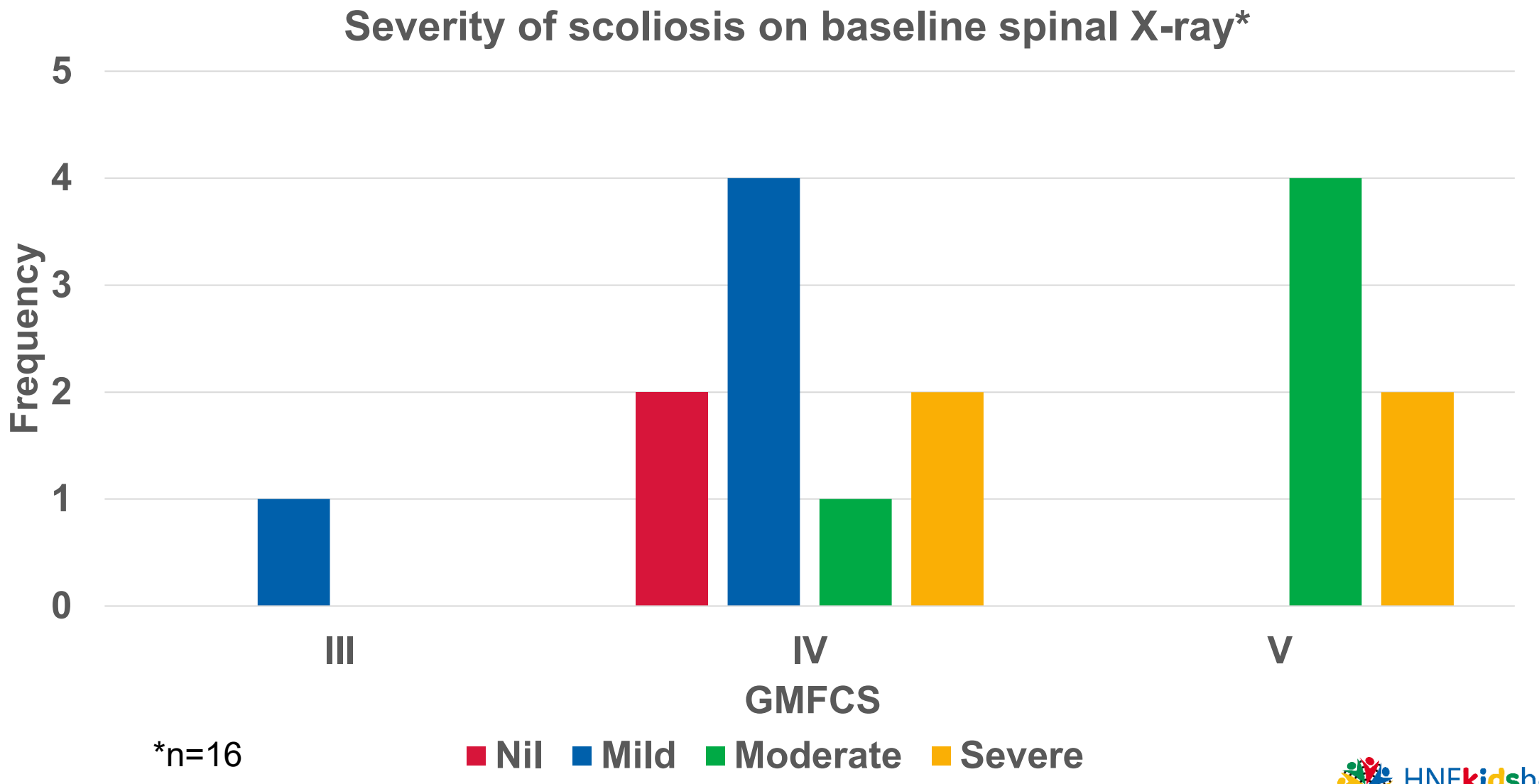
Interim Analysis



*n=16

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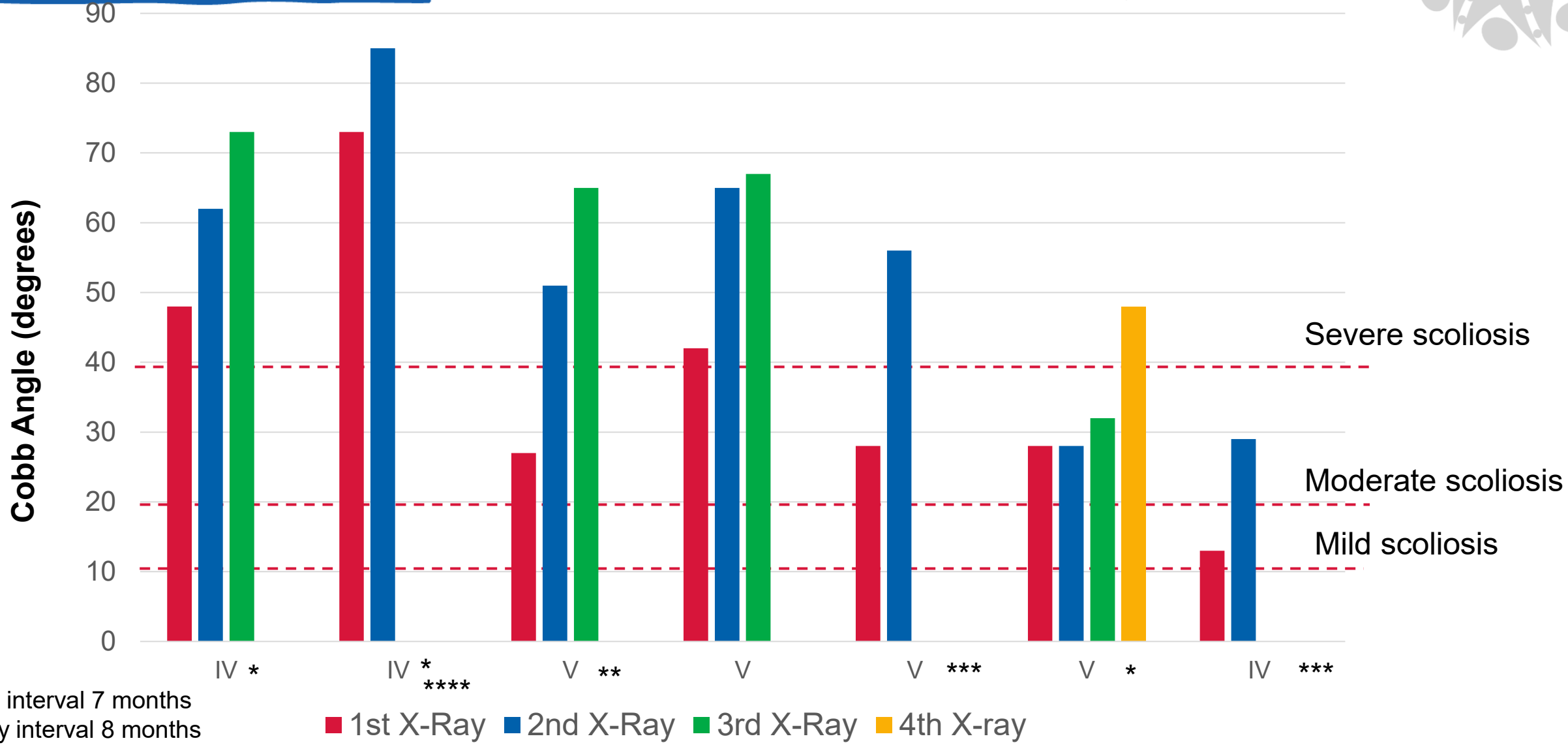
Interim Analysis

Cobb^{o} $\Delta \geq 10$ across spinal X-rays



* X-ray interval 7 months
** X-ray interval 8 months
*** X-ray interval 9 months
****patient withdrew after 2nd X-ray

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Interim Subgroup Analysis

Subgroup - Cobb^{O} Δ $\geq$ 10 degree across spinal X-rays n=6
• n=5 hip subluxation or dislocation
• n=4 hip surgery
• n=5 male, n=1 female
• Mean Age 12.9 years
• CP type n=2 dystonic quadriplegic, n=4 spastic dystonic quadriplegic

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Recommendations for Spinal Surveillance for children with CP GMFCS IV and V

- From age 8, 12 monthly spinal X-rays
- From age 8 with a history of hip subluxation/dislocation, 6 monthly spinal X-rays
- Cobb^{O} > 40 degrees, 6 monthly spinal X-rays
- Cobb^{O} > 25 degrees and patient is approaching pubertal growth spurt, 6 monthly spinal X-rays

Discussion

Inter- rater measurement reliability good overall

- 1 spinal X-ray - 2/3 consensus
- 1 spinal X-ray - no consensus

Limitations:

- Small sample size
- Limited data for recommendations for GMFCS III
- Spinal X-rays physically challenging in this cohort
- Barriers for participants adhering to 6 monthly X-ray interval
- Ideally capture timing of spinal curve progression in relation to pubertal growth spurt, difficult to consistently measure height in this cohort

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Future Outcomes

Further analysis is required after data collection is complete:

- Observe change in Cobb angle over the protocol timepoints.
- Analyse patient characteristics, strategise which patients would benefit more frequent surveillance spinal X-rays.

Bigger Picture:

- Unique research project in Australia.
- Develop a national guideline radiological spinal surveillance for children with CP.

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Thank you !